Ilg & Wagner, Jr.

Economy of Steel-Trussed Roofs

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ECONOMY OF STEEL-TRUSSED ROOFS

BY

GEORGE MARTIN ALOYSIUS ILG
ROBERT CHARLES WAGNER, JR.

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THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

GEORGE MARTIN ALOYSIUS ILG and ROBERT CHARLES WAGNER, JR.

ENTITLED ECONOMY OF STEEL TRUSSED ROOFS

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE

DEGREE OF Bachelor of Science in Civil Engineering

F.O. Dufour
Instructor in Charge

APPROVED: John P. Brooks

HEAD OF DEPARTMENT OF Civil Engineering

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ECONOMY OF STEEL TRUSSED ROOFS

I. INTRODUCTION

The economy of steel trussed roofs is a subject which has seemingly been neglected as compared with the many treatises on the economy of bridges and other engineering structures, and so the writers decided to take this for a thesis subject.

Fowler's 'General Specifications for Steel Roofs and Buildings' and Ketchum's 'General Specifications for Steel Framed Mill Buildings' have served as references in the designing of the trusses.

ART.I. ROOF LOAD

Corrugated steel of U.S. Standard Gage, left black and painted after erection, is used. The weight used is that for standard corrugations 2 1/2 inches wide and 5/8 inches deep. The desirability of corrugated steel roofing and its low first cost has given it a large demand for use in factory and shop buildings. It is placed directly on the purlins and held by the use of an iron strap placed underneath and fastened on each side by a small rivet, usually 3/8 inch in diameter. Stock lengths of the corrugated steel can be obtained directly from the mills, from five feet up to ten feet in length varying by one foot, and are easily placed in position by the workman of average intelligence. The use of any roof covering other than that used in this investigation will simply increase the panel load and not effect the conclusions drawn.

The purlins are spaced for a safe load of thirty pounds per horizontal square foot of roof surface, on the corrugated steel considered as a simple beam.

Rankine's formula for the safe span of corrugated steel is:

$$W = \frac{4}{15}\,\frac{Shbt}{l}$$

where: W = safe load in pounds,

S = working stress in pounds,

h = depth of corrugation in inches,

b = width of sheet in inches,

t = thickness of sheet in inches, and

l = clear span in inches.

$$W = \frac{4}{15}\,\frac{Shbt}{l}$$

$$l = \frac{4}{15}\,\frac{Shbt}{W}$$

Using Number 16 U.S. Standard Gage.√

$$l = \frac{4}{15}\,\frac{58000 \times 5/2 \times 7/8 \times 1/16}{30}$$

l = 70.47 inches

70.47 inches = 5.87 feet span.

Panel joints are so designed as not to exceed this spacing of 5.87 feet.

ART. 2 PURLINS

Angles, channels, I-beams and Z-bars are used for purlins. Each have special advantages in particular cases, but in practice are often used at random without regard to span or connections. The Z-bar is the most economical as far as strength for a given weight is concerned since its radius of gyration increases where that of the other shapes decrease, when placed on a sloping roof. The channel is also a desirable shape, but due to

the small width of flanges, allows but one rivet at each end. A lug angle is considered riveted to the channel and to the upper chord member, thus giving a desirable connection. Sag rods were used for spans over 16 feet. Trussed purlins will not be considered, since they are uneconomical and serve only in special cases. The extra expense of riveting, shaping and punching them must be considered.

ART. 3. DESIGN OF PURLINS.

The load considered in the design of the purlins is a combination of roof covering, snow, and wind considered as a certain number of pounds per square foot of horizontal projection of roof surface. This is the method in use in the best practice. The following computations and discussions will show the selected loadings.

I. LOADS ON THE TRUSS.

ART. 4. ROOF COVERING LOAD.

Weights of corrugated steel as given by Fowler is as follows:

U. S. Standard Gage,	20	18	16
Weight in pounds per sq. ft.	1.90	2.60	3.30

For galvanizing add 0.2 pounds per square foot.

ART. 5. SNOW LOAD.

According to the building laws of Chicago, New York and other cities, as well as the specifications of prominent railroads, a value of 20 pounds of snow per square foot of horizontal projection, appears to be a maximum. This value is also shown to be the amount of snow load per square foot of horizontal projection, for a 1/4 pitch roof in latitude 40°-42° North. Fowler gives the following values for the Central States, viz:

Pitch of roof,	1/3	1/4	1/5
Pounds per sq. ft. of horizontal projection,	7	15	22

It is customary to figure snow load in terms of pounds per square foot of horizontal projection of roof surface.

Since a cubic foot of snow weighs approximately 4 pounds and is considered as 6 pounds in the computations of European Engineers, it appears reasonable that a region having a 3 feet depth as a maximum snow fall, should allow between 12 and 18 pounds as a safe load.

ART. 6. WIND LOADS.

A great many formalae and theories have been advanced, from time to time, regarding wind pressures. The most common and universally accepted formula appears to be as advanced by Hutton:

$$P = 0.004v^2$$

Where: P = pounds pressure on one square foot of vertical surface.

v = velocity of the wind in miles per hour.

Other formulae which have been suggested, are:

Rouse, $P = 0.00492v^2$,

Hazen, $P = 0.00345v^2$,

Froude, $P = 0.0036v^2$,

Smeaton, $P = 0.0049v^2$, and

Nipher, $P = 0.0025v^2$.

Comparison of values obtained by substituting in the Nipher and Hutton formulae:

TABLE I.

Velocity of the wind in mi/hr.	Nipher. $0.0025\ v^2$ Pressure in lbs.	Hutton. $0.004\ v^2$ Pressure in lbs.
10	0.25	0.40
20	1.00	1.60
30	2.25	3.60
40	4.00	6.40
50	6.25	10.00
60	9.00	14.40
70	12.25	19.60
80	16.00	25.60
90	20.25	32.40
100	25.00	40.00

Professor Nipher advances a formula which gives results much lower than any one of the older formulae. His experiments, conducted within the past six years, have been performed with the greatest care and arrangement of apparatus. Experiments made in Germany indicate that normal wind pressures are much lower than is generally supposed, and that the effect of suction on the leeward side of the truss is unusually large and should be considered.

The pressure on the inside of the building increases as the velocity of the wind increases to windward and may cause the resultant force of the wind to equal zero on the windward side of trusses of very flat pitches. Openings in walls on the wind-

ward side or the location of the adjoining buildings have a marked effect upon the wind pressures, and at times of high wind velocity will cause concentrated pressures on the windward side of the roof, as shown in Fig. I.

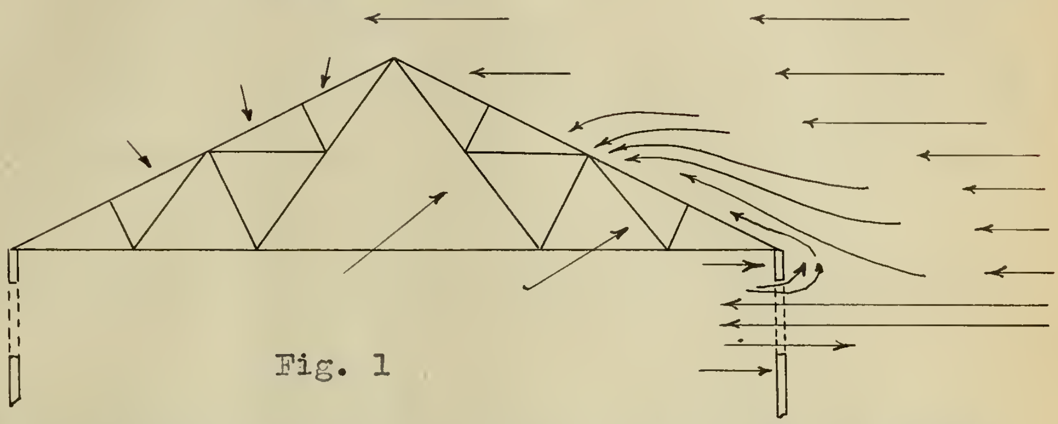

Fig. 1

Assuming the greatest wind velocity with which we can expect to deal to be a hurricane at a rate of 100 miles per hour, then we will have, according to Nipher, a pressure of 25 pounds per square foot of vertical surface.

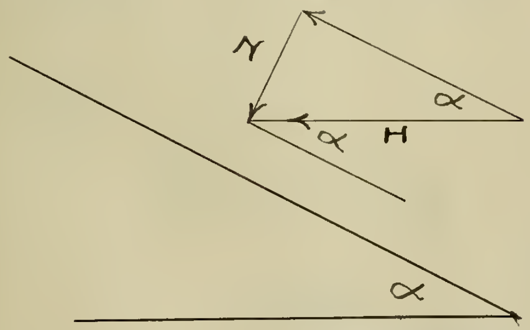

Fig. 2

Figure 2 gives us the graphical relation of the normal pressure on the roof caused by the wind blowing at a velocity of 100 miles per hour. Assuming the roof to have a 1/4 pitch, then $\sin\alpha = 1/\ 2.28$, and the normal pressure on the roof, $N = H \sin\alpha$, where:

N = normal pressure in pounds.

H = horizontal pressure in pounds.

$N = H \sin\alpha = 25 \times 1/2.28 = 11$ pounds.

Although Chicago and New York Building Laws specify 30 pounds, it is probable that a value of 25 pounds is more nearly correct. In review of the above conditions and loadings, it appears that a combination of sheet ice, and snow may occur in some localities and result in the assumed maximum loading. It is highly improbable that a maximum wind pressure will occur at the same time as maximum snow and ice pressures. Wind at a high velocity will blow the snow from the roof and cause the corrugated steel to weave back and forth, loosen the ice which will then slide from the roof.

The maximum loading will occur when the combination of sheet ice and snow is followed by a strong wind which is at the point of causing the ice to free itself from the roof covering. This loading per square foot of horizontal projection of roof surface is as follows:

Wind,	9.00	pounds.
Ice and snow,	18.00	"
Corrugated Roof,	3.60	"
Total,	30.60	"

The above loading on corrugated iron U. S. Standard Gage No. 16 will allow of the following span. Formula given in Dufour's Roof Trusses:

$$W = (330\ S\ dt)/l^2$$

Where: l = unsupported length in inches,

W = 30.6 pounds per square foot,

t = thickness of iron in inches,

s = allowable unit stress, and

d = depth of corrugations.

$$W = (330\ sdt)/\ l^2$$

$$l = \sqrt{(330\ sdt)/W}$$

$$l = \sqrt{\frac{(330 \times 16000 \times 2.5 \times .065)}{30.6}}$$

$$l = 170 \text{ inches} = 14.16 \text{ feet.}$$

This will not support the weight of a man on the roof, and, therefore, we will use a span of 5.87 feet as demonstrated on a preceding page.

The weight of purlins per square foot of horizontal projection of roof surface is approximately 3.00 pounds.

ART. 7. TOTAL ROOF LOADS.

The weight of trusses was assumed in accordance with the Ketchum formula given on page 9 . A fifty foot span gives a weight of 3.03 pounds per sq. foot of horizontal projection.

The summation of loads for which the trusses are designed, is as follows:

Weight of truss,	3.03	pounds.
" of snow,	18.00	"
Wind,	9.00	"
Weight of Roof Covering,	3.60	"
Weight of Purlins,	3.00	"
Total,	36.63	"

The dead load of the truss was assumed at 3.03 pounds per square foot of horizontal projection of roof surface, although it varies, as we might expect, according to the material used in its construction, the load capacity, the span, the distance between

trusses, and the pitch. The exact weight of any truss cannot be determined exactly until after the truss has been detailed. It is customary to compute the weight by one of the following weight formulae:

Author.	Total Weight in pounds.	Weight per square foot of horizontal projection.
Merriman,	$3/4\ aL(1 + L/10)$	$3/4\ (1 + L/10)$
Maurer,	$aL\ (1 + L/25)$	$(1 + L/25)$
Ricker,	$aL^2(1/25 + L/6000)$	$L\ (240 + L)/6000$
Ketchum,	$PaL/45(1 + L/5\sqrt{a})$	$.89(1 + L/5\sqrt{a})$
Fowler,	$aL(0.05L + 0.5)$	$0.05L + 0.5$

Where:

W = weight of steel in truss in pounds.

P = load capacity in pounds per square foot of horizontal projection.

r = rise in feet.

a = distance center to center of trusses.

L = span of truss in feet, and

w = weight of truss per square foot of horizontal projection of roof.

ART. 8. DESIGN OF TRUSSES.

We have departed from specifications and selected the compression formula (16000 – 70 L/r) which is endorsed in over forty bridge specifications of the leading railroads of the United States and Canada. J. G. Shyrock, Eng. News, Jan. 21, 1909, after a comparison of the many formulas, states that in the light of our present knowledge, the straight line formula of the American Ry. and maintenance of Way Ass'n., 16000 – 70 L/r, seems to be best suited

to meet the needs of current practice, and that it is rapidly coming into favor with those of the profession engaged in the design of framed structures. The Gordon formula in the form $\frac{17000}{1 + l^2/11000r}$ is also used but appears to be losing favor.

The compression formula, 16000 - 70L/r, showing the safe stress in pounds per square inch is plotted on page 23 for values of L/r from 30 to 200.

Curves for radii of gyration of standard angles with equal and unequal legs, back to back, from zero to one and three-fourth inches varying by sixteenths of an inch were plotted for the design of the trusses, from values given in Cambria and Carnegie. This saves interpolation when using plates varying by one sixteenth of an inch, and gives values which are not found in the hand books.

In order to make an intelligent study of the conditions governing the economic design, it was necessary to study the effects of pitch, span and spacing of the trusses. The type of web chosen for a given span is such as to allow the placing of purlins at panel points without exceeding the maximum allowable span for the corrugated steel roof covering. The cost of designs, shop and erection will only be mentioned as directly effected by the method used.

To allow a convenient investigation the trusses are considered as resting on the side walls, and not fastened to columns or knee braces.

II. ECONOMIC STUDY

ART. 9 ECONOMY OF TYPES

A comparison of Fink, Pratt and Howe trusses was made in order to determine the most economical type to use in the investigation. The results are shown in Table II.

TABLE II. ECONOMIC TYPE

Type	Span	Rise	Pitch	Spacing	Weight-W	Details	Relative Efficiency
Pratt	60	15	1/4	16'	2815	20%	89.1%
Howe	60	15	1/4	16'	2816	21%	89.0%
Fink	60	15	1/4	16'	2517	18%	100.0%

The Fink type is shown to be the most economical one to use. Recent practice recommends the Fink type as the most economical. The triangular type is used up to spans of 125 feet above which the crescent type is used in practice. The Fink type has the advantage of short compression members, simplicity of details and duplicate sections and details. The diagram of the truss depends upon the allowable spacing of the purlins and will have the pleasing arrangement of a panel point under each purlin. The lower chord is designed horizontal but practice sometimes allows for a slight camber and higher stresses in order to prevent the optical illusion of sag in the perfectly horizontal chord.

The Fink type was studied with regard to its economy under different conditions of span, rise and spacing. This study, investigated in detail, was found to be in a field of almost un-

limited extent.

ART. 10. ECONOMICAL PITCH

The determination of the economical pitch for the various spans was next investigated as shown in Table III. These trusses were drawn to scale and the stresses obtained by simple graphical analysis. The members were then designed and the weights computed and listed in Table III.

TABLE III

ECONOMIC PITCH

Type	Span	Pitch	Spacing	Weight	Lbs. Hor.Sq.Ft.
Fink	40	1/5	16	1334	2.09
"	40	1/4	16	1287	2.01
"	40	30°	16	1354	2.12
"	40	1/3	16	1440	2.25
"	60	1/5	16	2594	2.76
"	60	1/4	16	2517	2.675
"	60	30°	16	2513	2.67
"	60	1/3	16	2724	2.90
"	80	1/5	16	4582	3.58
"	80	1/4	16	4370	3.41
"	80	30°	16	4372	3.42
"	80	1/3	16	4380	3.75
"	100	1/4	16	6534	4.08
"	100	30°	16	1427	4.02
"	100	1/3	16	6562	4.18

The ratio of the rise to the span of the truss is termed pitch and is designated by the fractions 1/5, 1/3, 1/4 etc. The pitch is also designated by the angle the top chord makes

with the horizontal as in the instance of the 30 degree pitch. The results are given graphically on pages 24 to 30 inclusive.

ART. 11. ECONOMICAL SPACING OF TRUSSES

A series of trusses with various spans and spacings were designed, and the weights computed in pounds per horizontal square foot of roof surface. The combined weight of truss and purlins in pounds per horizontal square foot of roof surface was also computed.

These results are listed in Table IV,

TABLE IV.

ECONOMIC SPACING OF TRUSSES				
Span ft.	Pitch Span Rise	Spacing ft.	Unit Truss Lbs. hor.	Weight Truss & Purlins sq. foot
60	1/4	12	3.12	4.64
60	1/4	16	2.72	4.59
60	1/4	20	2.53	5.16
80	1/4	12	3.83	5.29
80	1/4	16	3.41	5.21
80	1/4	20	3.12	5.65
100	1/4	12	4.33	5.76
100	1/4	16	4.08	5.84
100	1/4	20	3.75	6.72

and plotted graphically on pages 33, 34 and 35.

ART. 12. EFFECT OF SPAN ON WEIGHT

The variation of the weight of the truss, in pounds per horizontal square foot of roof surface, with variation of span and spacing of trusses was computed and listed in the Summary of Results, Table V. Graphical representation of the results is shown on pages 31 & 36.

III. WEIGHT OF STEEL TRUSSED ROOFS

ART. 13. COMPUTATION OF WEIGHTS

The investigation of the weights of steel roof trusses of the Fink type will be classed into three parts as follows, viz: Formula, Practice and Authors Designs.

The first part consists of the comparison of weights as given by a number of formulae in common use today. These are shown in the Summary of Results, Table number V on page 21. These formulae were reduced to an expression for the weight of the roof truss in pounds per horizontal square foot of projection on the roof.

The data for the second part was figured from the detail sheets of trusses of the Fink type with various spans as designed and detailed by the writers and erected in recent practice. That per cent of the weight of the truss taken by the details was found to be about 19 with a range of 1 1/2 per cent. Different designers do not vary greatly in their methods of detailing so the small variation was not unexpected. From an average of the results the conclusion drawn was that the details ordinarily are 19 per cent of the weight of the bare truss. These results were reduced to pounds per square foot of horizontal projection of the roof and tabulated in Table V of the Summary of Results on pages 21 & 22.

The data for the third part was obtained from the weights of the trusses designed by the writers and used in the preceed-

ing investigation of economical pitch, span and spacing. The weight is reduced to pounds per horizontal square foot of roof surface and tabulated in Table V on pages 21 & 22.

ART. 14. WEIGHT FORMULA

A formula, for the weight of steel trussed roofs of the Fink type, as recommended by the writers is:

$$W = aL(1 + 1/8\ L/\sqrt{a})$$

where: W = total weight of the trusses,

a = distance between trusses in feet, and

L = span of the trusses in feet.

This formula was obtained from the weights of trusses as designed in the preceding study.

The weights of various trusses, computed by this formula, are shown graphically on page 36.

When the load capacity of the truss is approximately 40 pounds per horizontal square foot of roof surface, the value obtained by the above formula is satisfactory. In case of a different loading due to heavier roof covering, sheathing, etc., the variable P is introduced as follows:

$$W = \frac{P}{40}\left(1 + \frac{1}{8}\frac{L}{\sqrt{a}}\right)$$

where: P = Combined wind and dead loads on the truss in pounds per horizontal square foot of roof surface, and the remainder of the notation is as before.

IV. CONCLUSIONS

The following conclusions are drawn by a comparison of the results given by the Tables and Curves on the preceding pages.

ART. 15. ECONOMICAL TYPE

The investigation of the Fink, Pratt and Howe trusses for a particular span and spacing indicates the former to be the more economical.

ART. 16. ECONOMICAL PITCH

The economical pitch for the various spans is shown by curves on page 30. In the instance of the 40 foot span the economical pitch of the truss is 1/4 as indicated on page 24. The curve on page 25 gives a pitch between 1/4 and 30° as the economical one for a span of 60 feet. The economical pitch for a span of 80 feet is also between 1/4 and 30°, and curve 5 indicates the 30° pitch to be economical for a span of 100 feet. Curve, 6, 7 & 8 give the theoretical economical pitch for various spans having a distance of 16 feet center to center of trusses. The difference in weight for pitches of 1/4 and 30° is very small, as given in the Table V, and indicates that either one may be used depending on other conditions of economy. The steeper pitch is to be preferred for regions having a large snow and ice load, but it gives a larger roof area and offers a greater vertical surface to the force of the wind. The cost of extra roof surface and area to be painted in the use of the 30° pitch, will compensate for the saving in the weight of the truss. The weight of purlins for the 1/4 and 30° pitches remains constant for a

given spacing of trusses. The 1/6 and 1/5 pitches require more metal and do not shed snow as easily as in the case of the 1/4 pitch. This latter consideration is a very important one when corrugated iron is used as a roof covering.

The flat pitches also require a larger lap of the corrugated steel roof covering in order to prevent leakage due to rain blown by the wind.

Considering everything, the 1/4 and 30° pitches are recommended as economical.

ART. 17. ECONOMICAL SPACING OF TRUSSES

The effect of the spacing of the trusses is indicated by curves on pages 33 & 34. Curve 9 indicates a decrease in the weight of the truss with increase in span and spacing. Curve 11 gives the economical spacing of trusses for combined weight of truss and purlins in pounds per horizontal square foot of roof surface for spacings varying from 12 to 20 feet and spans varying from 60 to 100 feet.

It is evident from the variation of the weight of the purlins plotted on 32 and the weight of the trusses plotted on 31 that the economical spacing for combined truss and purlins is such as to make their sum a minimum. The combined weight of truss and purlin, per horizontal square foot of roof surface, as plotted on page 34 shows the economical spacing of trusses. From the regularity of results shown, on page 33, it is reasonably safe to say that intermediate spans may be read from the curve.

Since the shop cost per pound of riveted trusses erected in recent practice is very closely 2 1/2 times that of rolled sections, the final economic spacing of trusses will be greater as

recommended by the curve on page 35.

Trusses are not always spaced economically, as thay are influenced by the location of columns and the features of a particular design and are frequently governed by the economic placing of the other steel work as in the case of the large steel framed buildings.

ART. 18. EFFECT OF SPAN ON WEIGHT

Curves 9 & 14 indicate the variation of the weight of the truss with the variation in span for 12, 16 and 20 feet spacing of trusses. The results show that the weight of the trusses in pounds per horizontal square foot of area covered increases with the increase in span.

Curves on page 36 give results as figured from theory and practice and is convincing in its results. The combined weight of truss and purlins also varies with the span. The shop cost per pound of metal used in the riveted truss also increases approximately with the span.

ART. 19. WEIGHTS OF STEEL TRUSSED ROOFS

The Summary of Results, Table IV, gives the weight of the Trusses in pounds per horizontal square foot of area covered for various conditions of span,spacing and pitch. Curves on page 36 give the same results in a form which allows of an easy rapid comparison of the weight formulas used in practice and that proposed by the writers.

It is noticed that the weight of the trusses as given by many of the formulas exceed the actual values as plotted for trusses of recent construction. This is due to the fact that, the formulae were deduced when the allowable unit stress was

much lower than is used today. It is also possible for the formulae to have been derived from trusses designed to withstand very heavy loading

The steel work was, possibly, of an inferior grade and consequently the sections were designed much heavier than is done in modern practice. Merriman's formula appears to be unreasonably high. Ricker's formula deduced for wood trusses with steel vertical rods gives values which are high for large steel trusses. Ketchums formula, although giving high values, is very consistent as compared with values of values of trusses as designed by the writers. This formula is the only one which considers the spacing of trusses as effecting the weight of the truss in pounds per horizontal square foot of the area covered.

The formula recommended by the writers does not consider the effect of the pitch on the weight of the truss since the weight was found to be only slightly effected by pitches used in practice.

This formula in the form of

$$W = \left(1 + \frac{1}{8}\frac{L}{\sqrt{a}}\right),$$

where: W = weight of truss in pounds per horizontal square foot of area covered,

L = length of span in feet, and

a = spacing of trusses in feet,

gives satisfactory values for trusses designed to support a live and dead load of approximately 40 pounds per horizontal square foot of area covered. These values are given on page in the Summary of Results and agree closely with values as figured from trusses erected within the last two years.

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TABLE V.

SUMMARY OF RESULTS

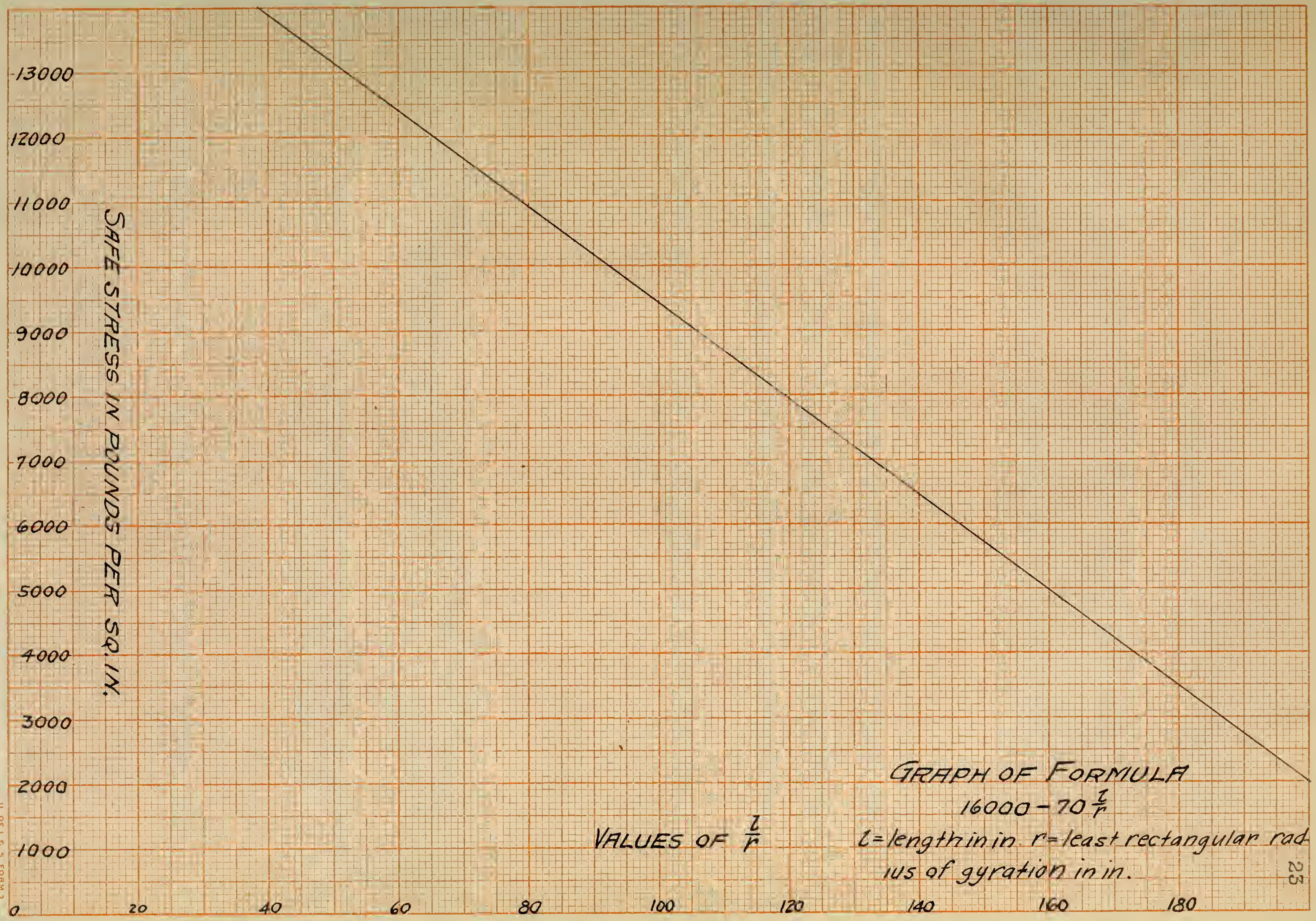
W = TRUSS WEIGHT (TOTAL). w = TRUSS WEIGHT (LBS. PER HOR. SQ. FT.).

SPAN OF TRUSS IN FEET = l	34	60	48	105	42	80	57	40	40	40	40	60	60	60	60	80	80	80
PITCH OF TRUSS SPAN ÷ RISE	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{5}$	$\frac{1}{4}$	30°	$\frac{1}{3}$	$\frac{1}{5}$	$\frac{1}{4}$	30°	$\frac{1}{3}$	$\frac{1}{5}$	$\frac{1}{4}$	30°
DISTANCE c-c TRUSSES = a ft	14	16	12	18	20	19	23	16	16	16	16	16	16	16	16	16	16	16
LOADING IN POUNDS = P	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
MERRIMAN $w = \frac{3}{4}(1+\frac{l}{10})$ =	3.30	5.23	4.35	8.62	3.90	6.72	5.02	3.75	3.75	3.75	3.75	5.27	5.27	5.27	5.27	6.76	6.76	6.76
MAURER $w = (1+\frac{l}{25})$ =	2.34	3.39	2.92	5.20	2.68	4.18	3.28	2.60	2.60	2.60	2.60	3.39	3.39	3.39	3.39	4.20	4.20	4.20
RICKER $w = l(\frac{240+l}{6000})$ =	1.56	3.00	2.31	5.03	1.96	4.23	2.85	1.87	1.87	1.87	1.87	3.00	3.00	3.00	3.00	4.26	4.26	4.26
KETCHUM $w = .89(1+\frac{l}{5\sqrt{a}})$ =	2.41	3.56	3.03	5.35	2.58	4.41	3.05	2.67	2.67	2.67	2.67	3.56	3.56	3.56	3.56	4.45	4.45	4.45
FOWLER $w = 0.05l + 0.5$ =	2.20	3.50	2.90	5.75	2.60	4.50	3.35	2.50	2.50	2.50	2.50	3.50	3.50	3.50	3.50	4.50	4.50	4.50
ACTUAL TRUSSES RECENT PRACTICE W =	1133.	2636	1604	10256	1619	6280	2458											
ACTUAL TRUSSES RECENT PRACTICE w =	2.38	2.74	2.80	5.38	1.92	3.93	1.90											
AUTHORS DESIGN w =		2.67				3.47		2.09	2.01	2.12	2.25	2.76	2.67	2.67	2.90	3.58	3.41	3.42
" $W = al(1+\frac{1}{8}\frac{l}{\sqrt{a}})$ w =	2.14	2.87	2.53	4.12	2.18	3.43	2.18	2.20	2.20	2.20	2.20	2.87	2.87	2.87	2.87	3.50	3.50	3.50

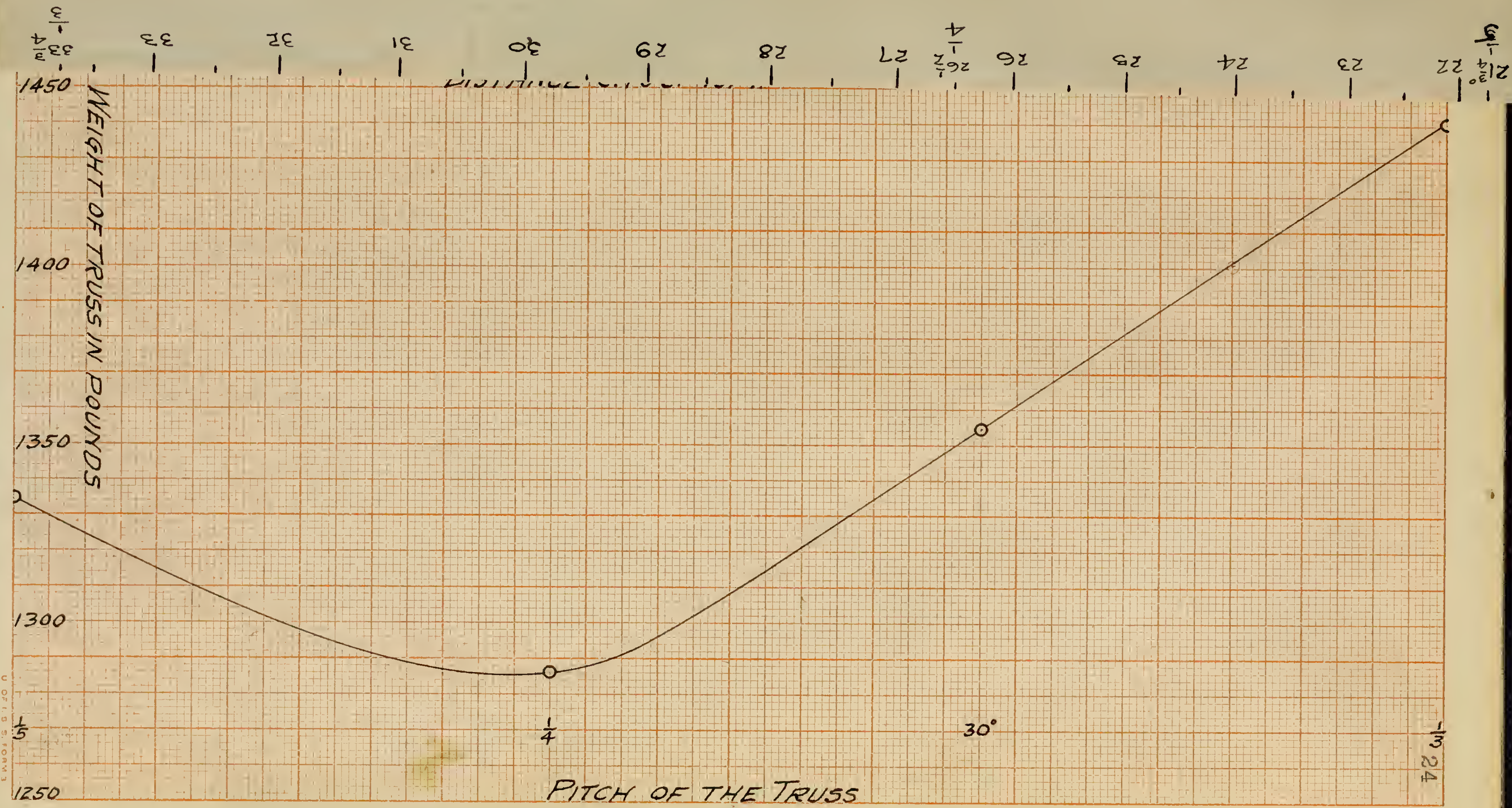
TABLE V.

SUMMARY OF RESULTS CONT'D.

w = TRUSS WEIGHT. (LBS. PER HOR. SQ. FT.)									
SPAN OF TRUSS $= l$ Ft.	80	100	100	100	100	100	80	80	80
PITCH OF TRUSS	$\frac{1}{3}$	$\frac{1}{4}$	30°	$\frac{1}{3}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$
DISTANCE c-c TRUSS $= a$ Ft.	16	16	16	16	12	20	12	16	20
LOADINGS IN LBS. $= P$	40	40	40	40	40	40	40	40	40
MERRIMAN $w =$	6.76	8.25	8.25	8.25	8.25	8.25	6.76	6.76	6.76
MAURER $w =$	4.20	5.00	5.00	5.00	5.00	5.00	4.20	4.20	4.20
RICKER $w =$	4.26	5.68	5.68	5.68	5.68	5.68	4.26	4.26	4.26
KETCHUM $w =$	4.45	5.34	5.34	5.34	6.02	5.34	4.98	4.50	4.58
FOWLER $w =$	4.50	5.50	5.50	5.50	5.50	5.50	4.50	4.50	4.50
AUTHORS $w =$	3.15	4.08	4.02	4.18	4.33	3.75	3.83	3.41	3.02
" $w = 1 + \frac{1}{8}\frac{l}{\sqrt{a}} =$	3.50	4.12	4.12	4.12	4.43	3.80	3.85	3.50	3.23

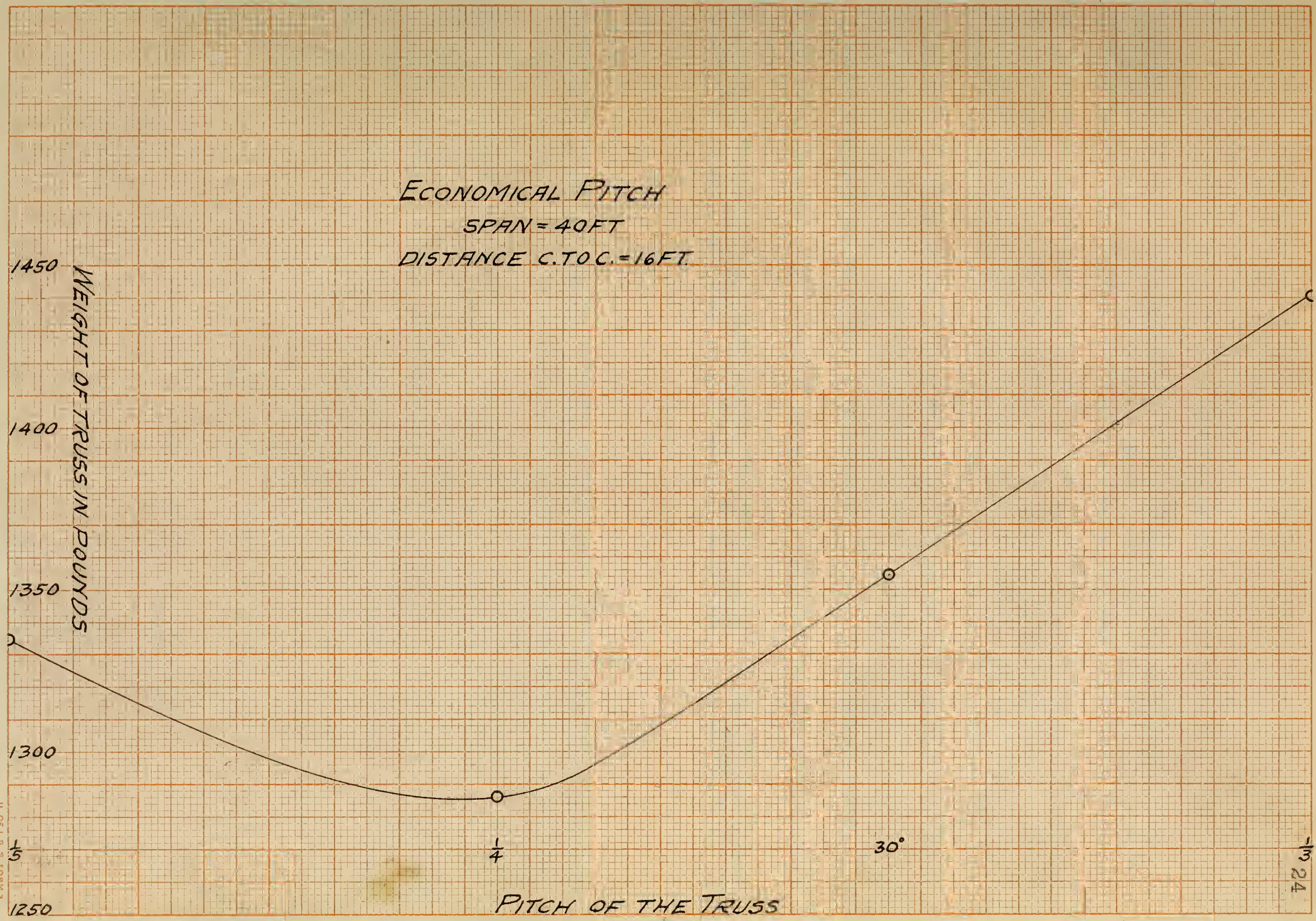


Graph of Formula
$16000 - 70\frac{l}{r}$
l = length in in. r = least rectangular radius of gyration in in.
Values of $\frac{l}{r}$
Safe stress in pounds per sq. in.
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
20
40
60
80
100
120
140
160
180

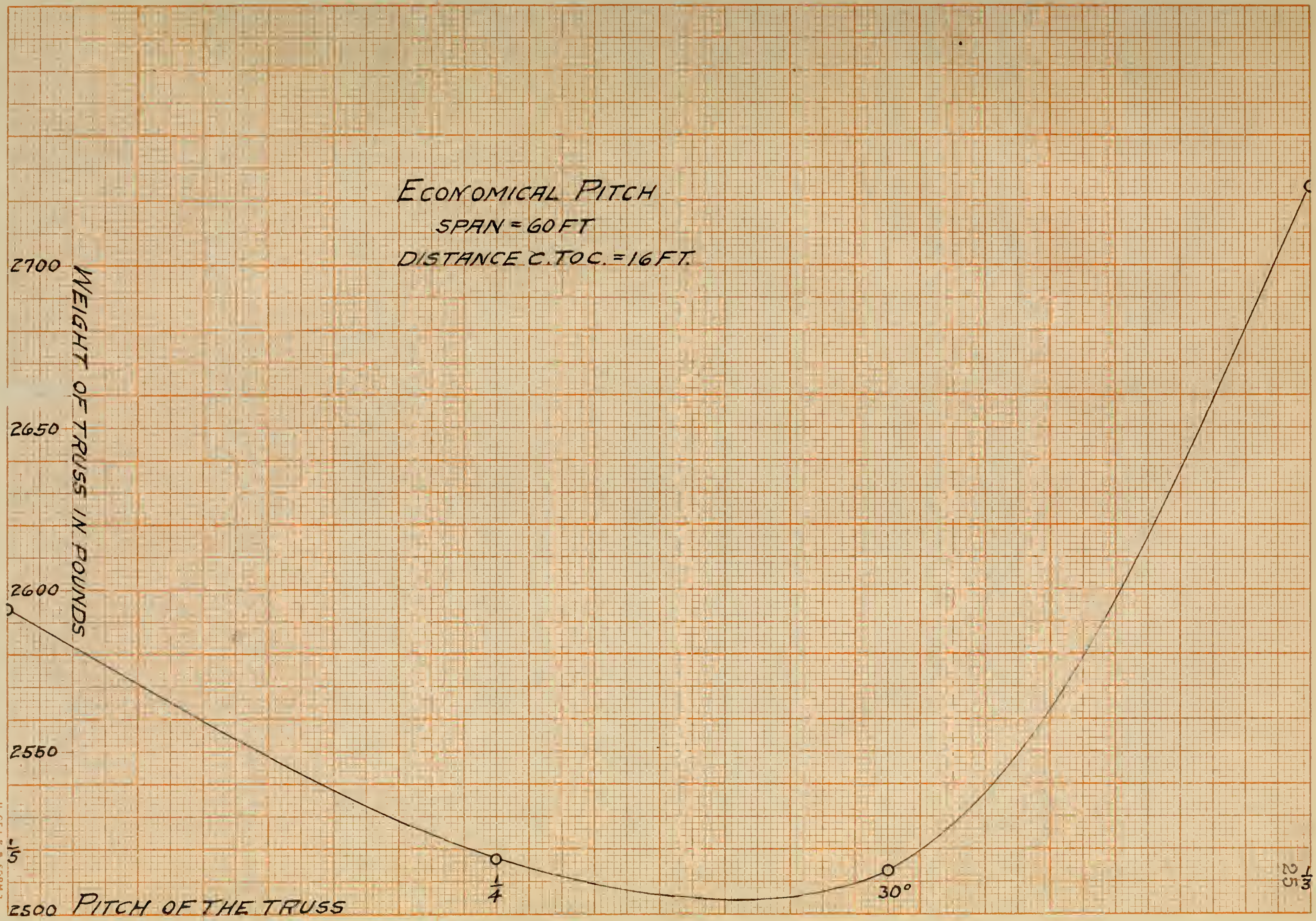


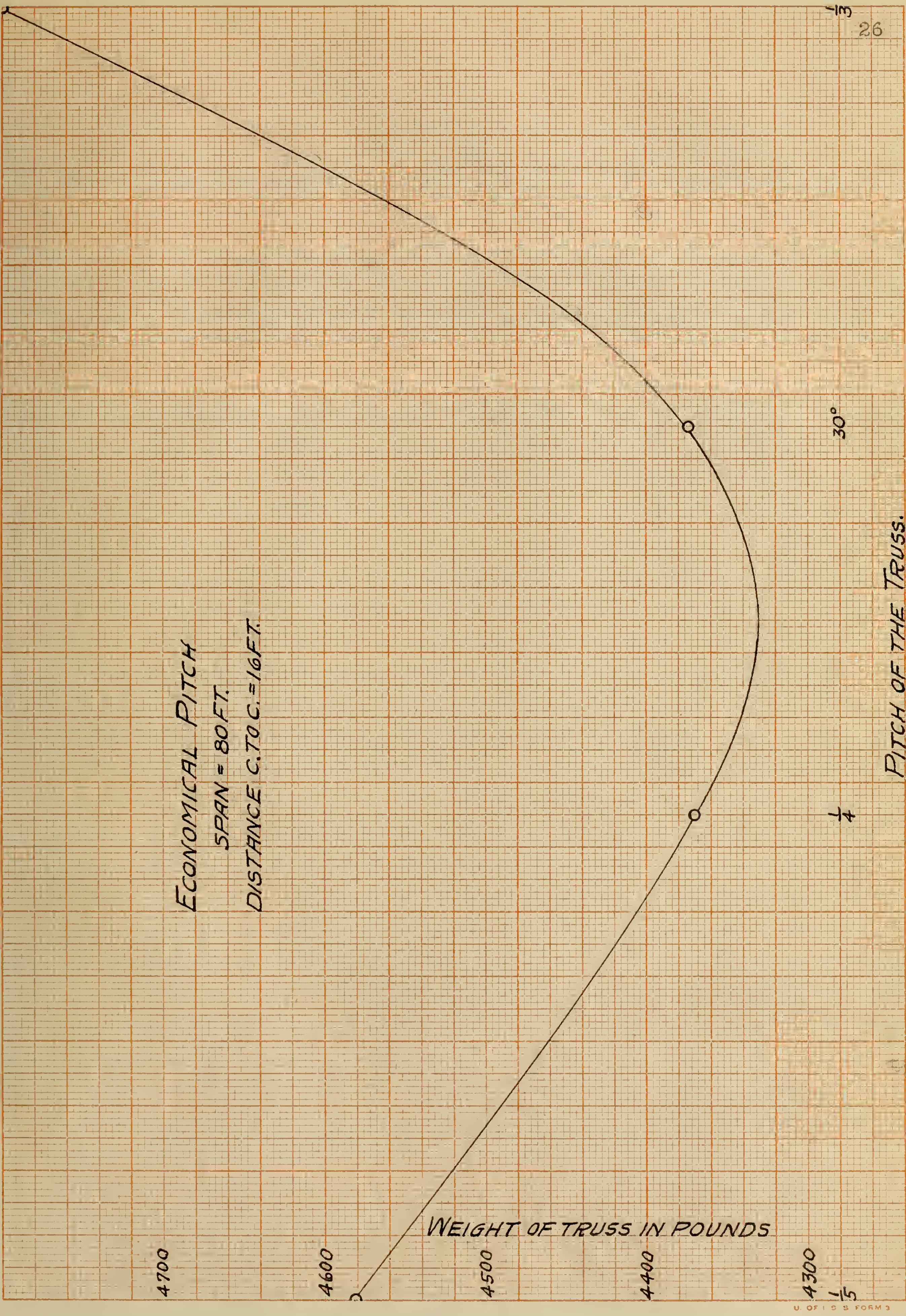
WEIGHT OF TRUSS IN POUNDS
1450
1400
1350
1300
1250
PITCH OF THE TRUSS
1/5
1/4
30°
1/3
22
23
24
25
26
27
28
29
30
31
32
33

24

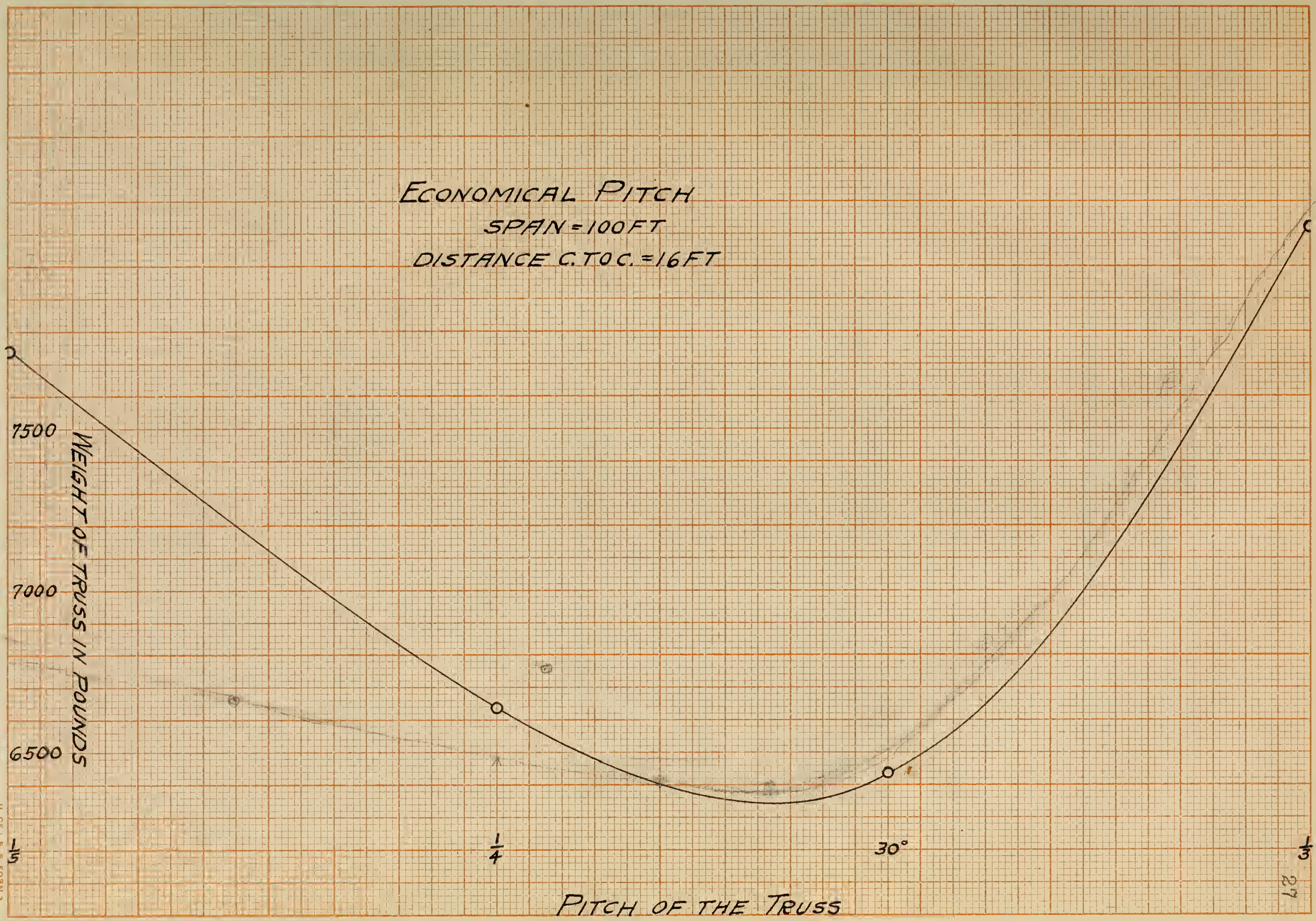


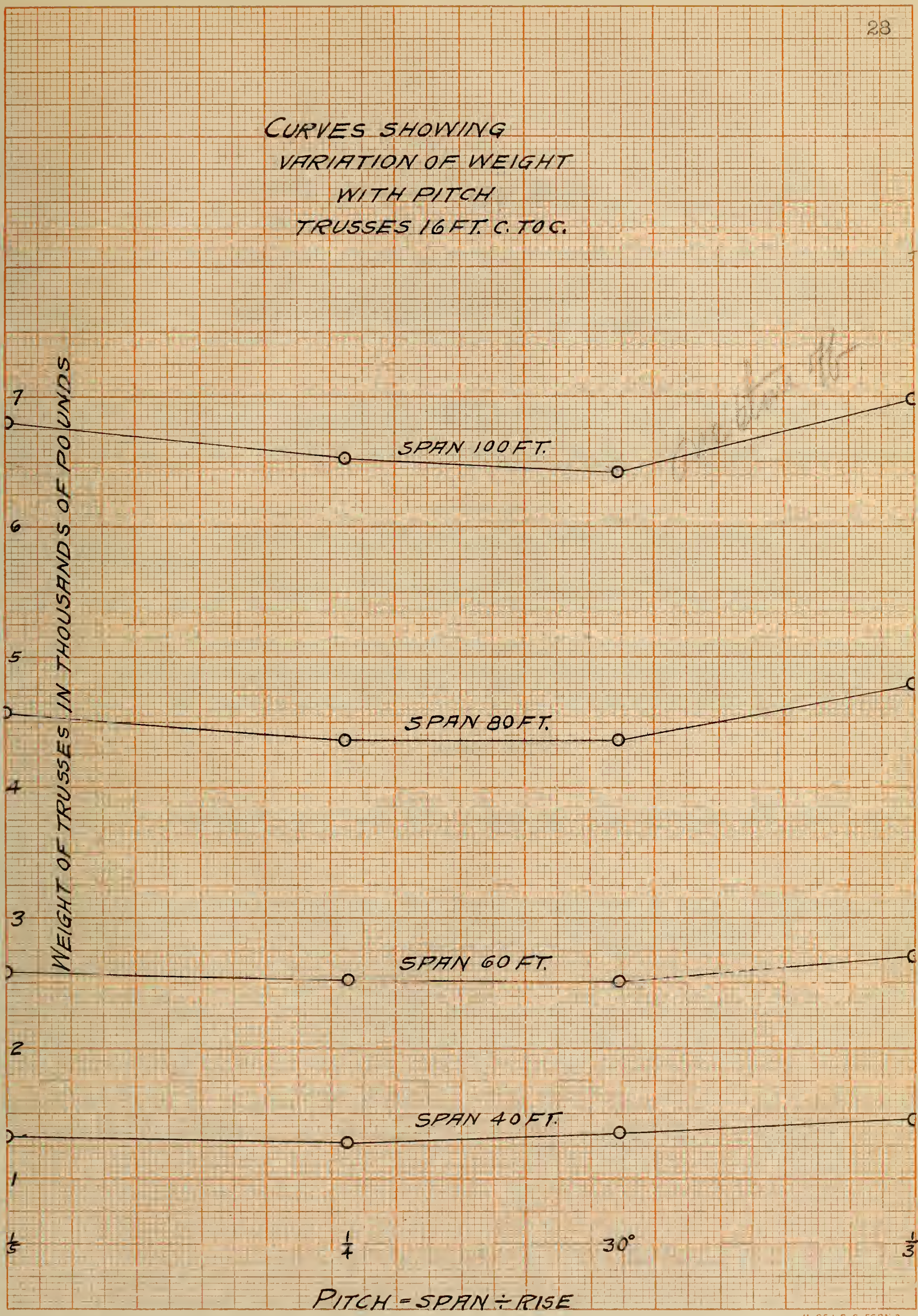
ECONOMICAL PITCH
SPAN = 40 FT
DISTANCE C. TO C. = 16 FT.
WEIGHT OF TRUSS IN POUNDS
1450
1400
1350
1300
1250
1/5
1/4
30°
1/3
PITCH OF THE TRUSS

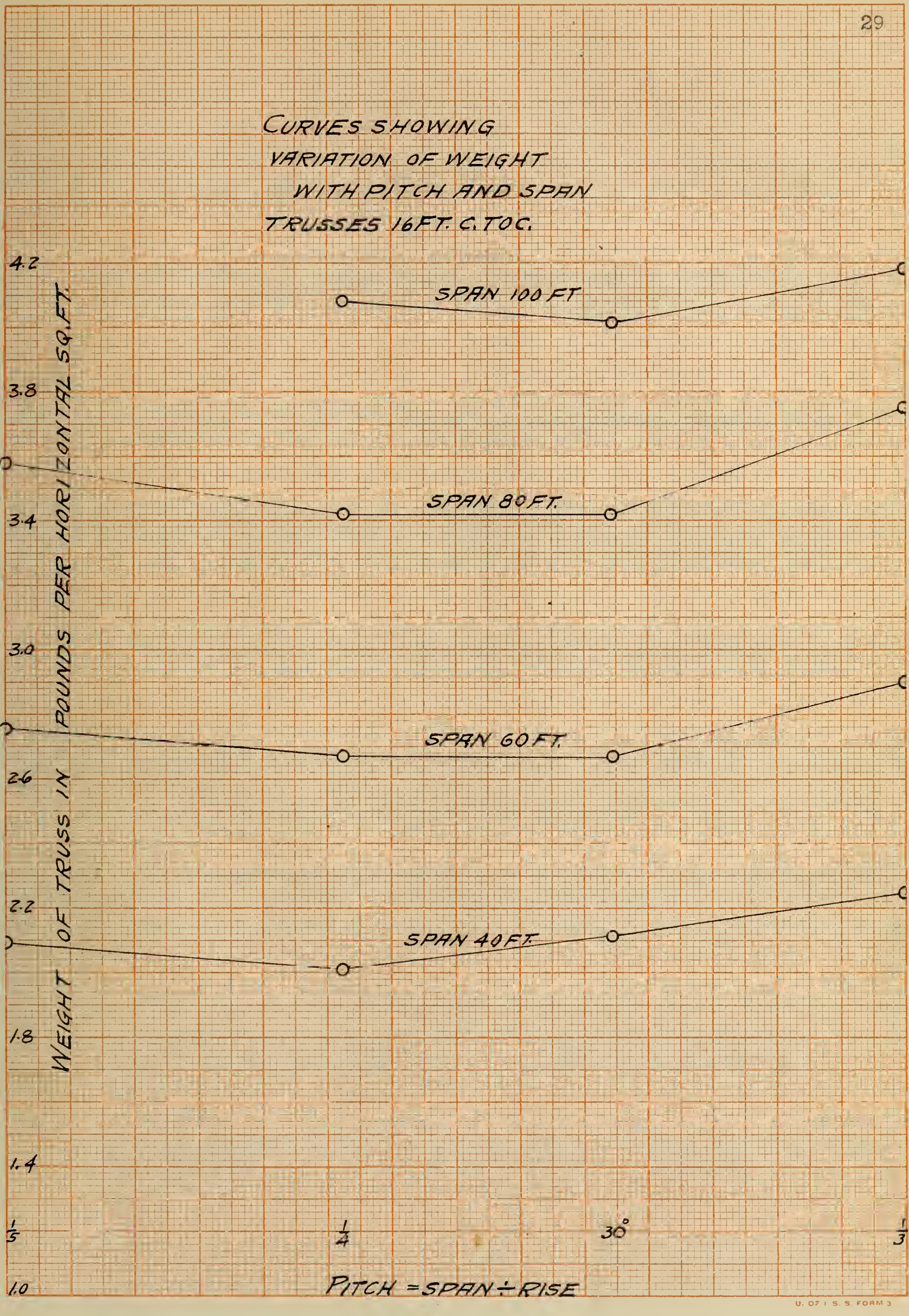

ECONOMICAL PITCH
SPAN = 60 FT
DISTANCE C. TO C. = 16 FT.
WEIGHT OF TRUSS IN POUNDS
2700
2650
2600
2550
2500
PITCH OF THE TRUSS
1/5
1/4
30°
1/3

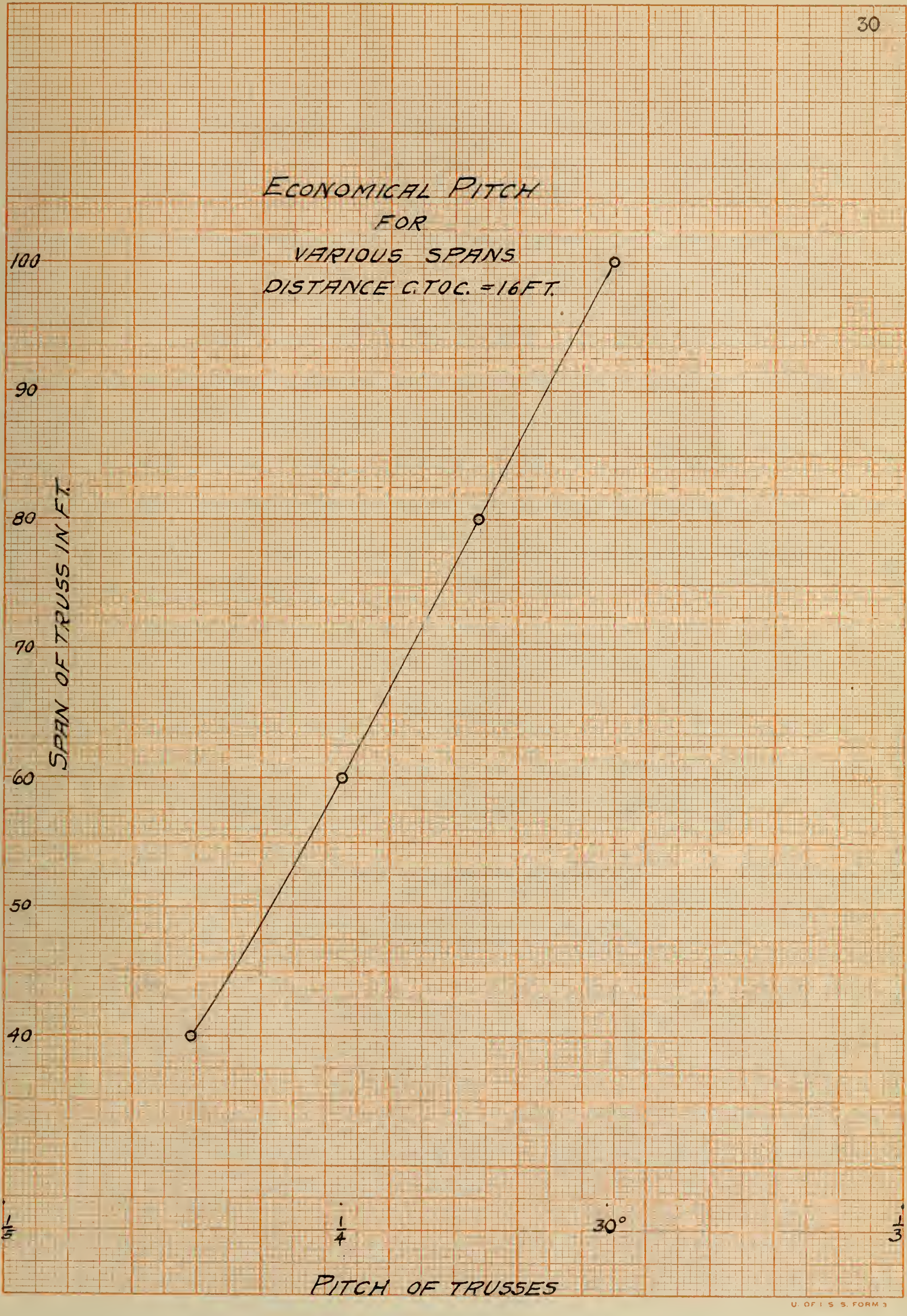


U. of I. S. S. Form 3

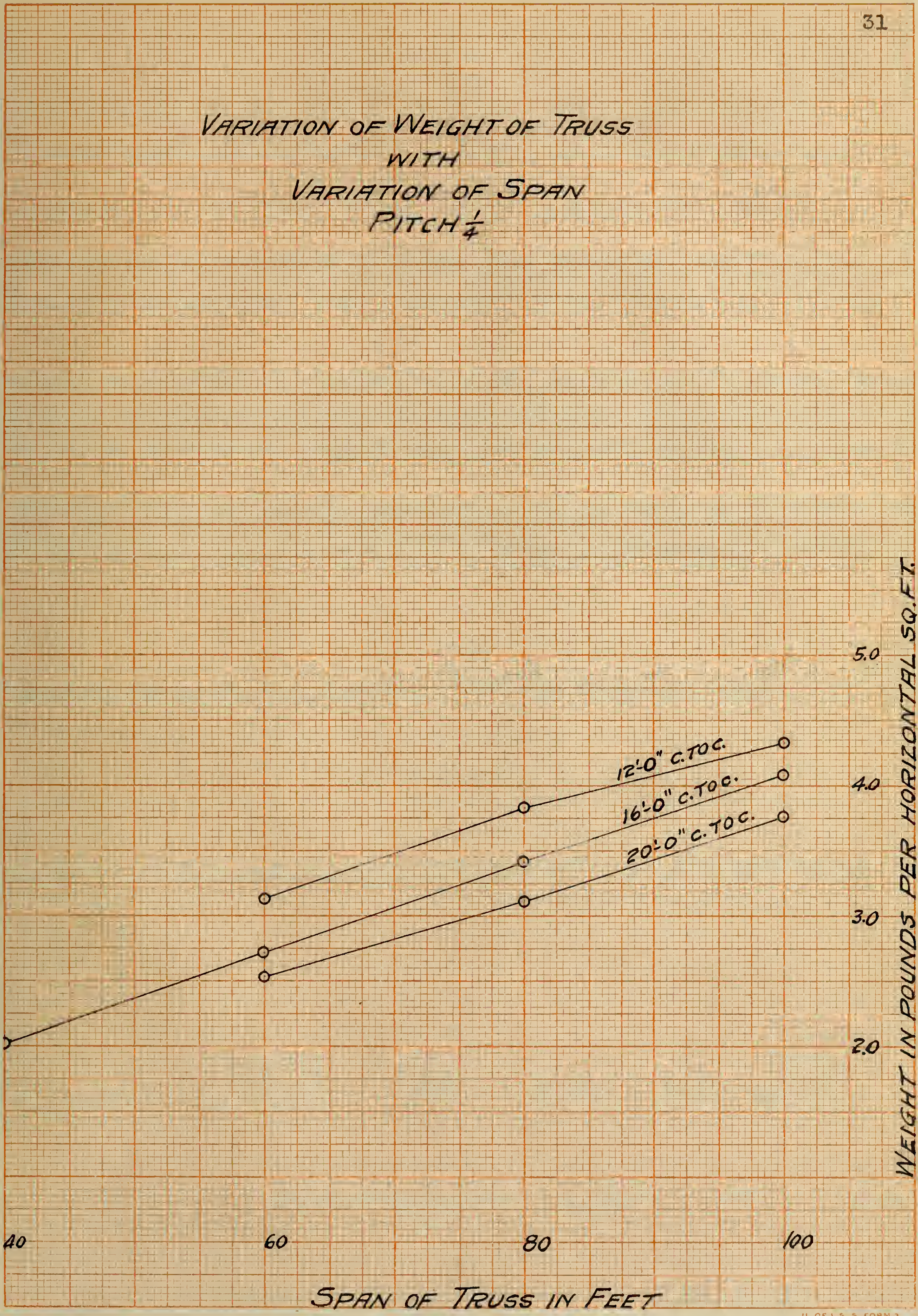

ECONOMICAL PITCH
SPAN = 100 FT
DISTANCE C. TO C. = 16 FT
7500
7000
6500
WEIGHT OF TRUSS IN POUNDS
1/5
1/4
30°
1/3
PITCH OF THE TRUSS
U. OF I. S. S. FORM 3

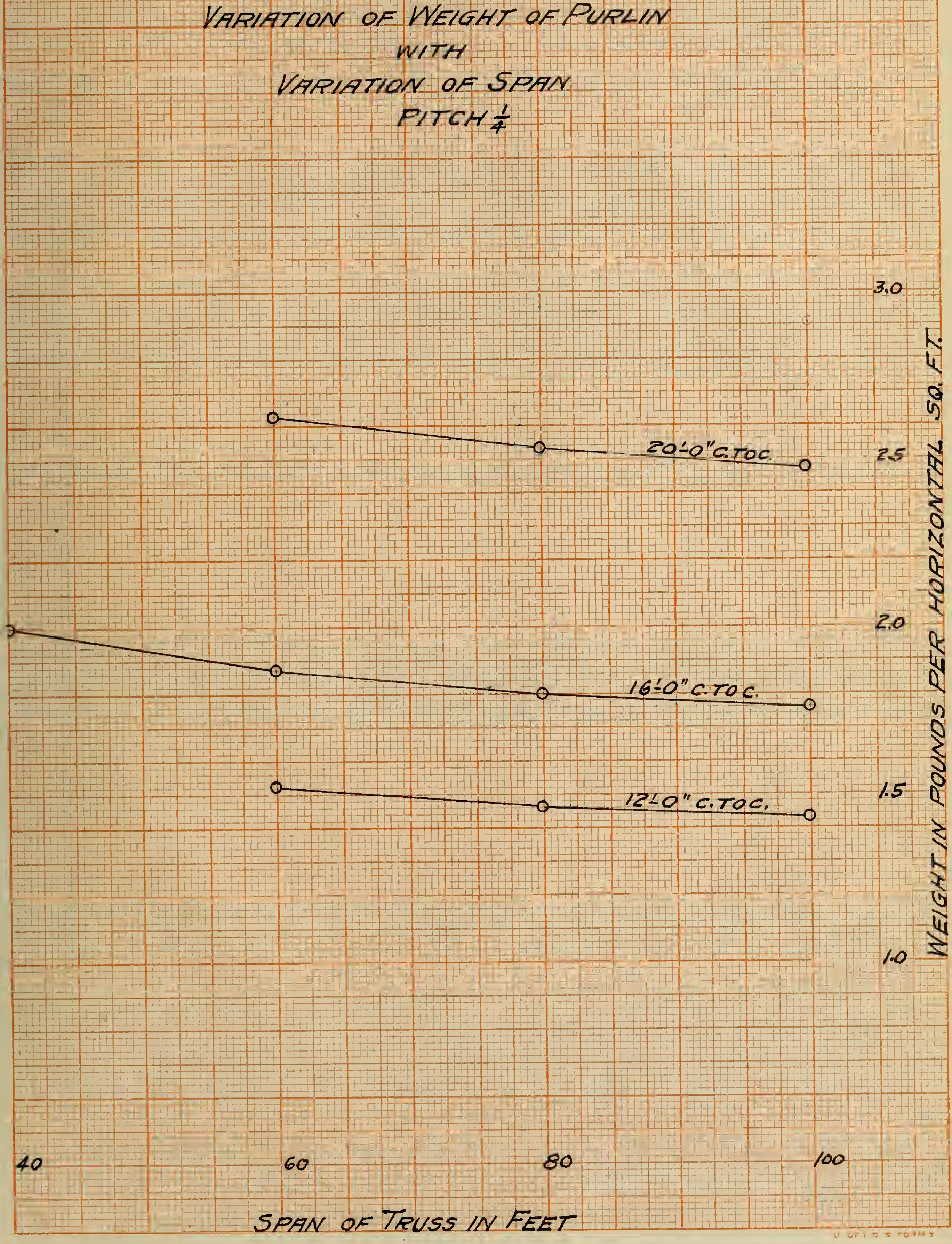

CURVES SHOWING
VARIATION OF WEIGHT
WITH PITCH
TRUSSES 16 FT. C. TO C.
WEIGHT OF TRUSSES IN THOUSANDS OF POUNDS
8.0
7
6
5
4
3
2
1
SPAN 100 FT.
SPAN 80 FT.
SPAN 60 FT.
SPAN 40 FT.
1/5
1/4
30°
1/3
PITCH = SPAN ÷ RISE


CURVES SHOWING
VARIATION OF WEIGHT
WITH PITCH AND SPAN
TRUSSES 16 FT. C. TO C.
SPAN 100 FT
SPAN 80 FT.
SPAN 60 FT.
SPAN 40 FT.
4.2
3.8
3.4
3.0
2.6
2.2
1.8
1.4
1.0
WEIGHT OF TRUSS IN POUNDS PER HORIZONTAL SQ. FT.
1/5
1/4
30°
1/3
PITCH = SPAN ÷ RISE

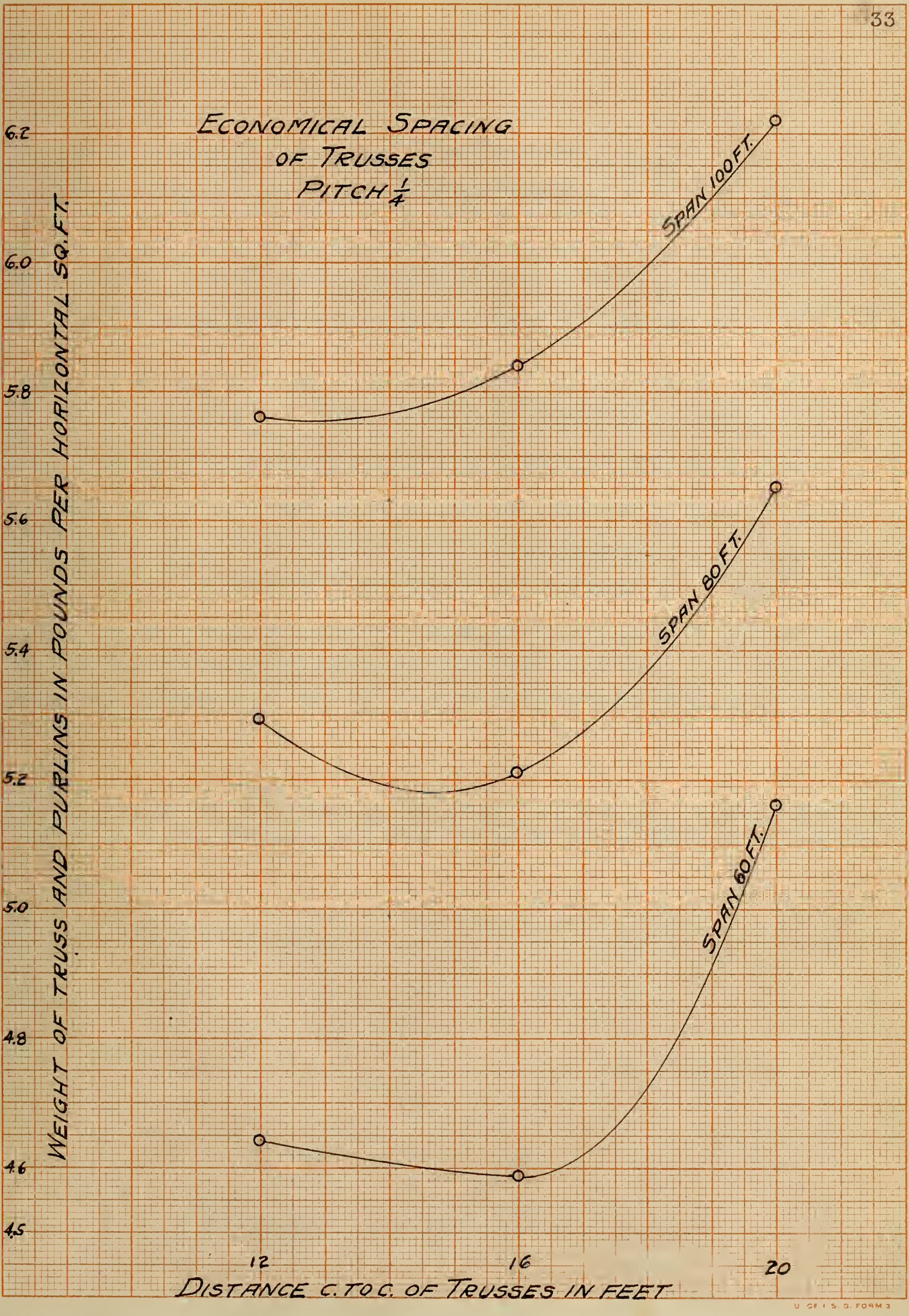


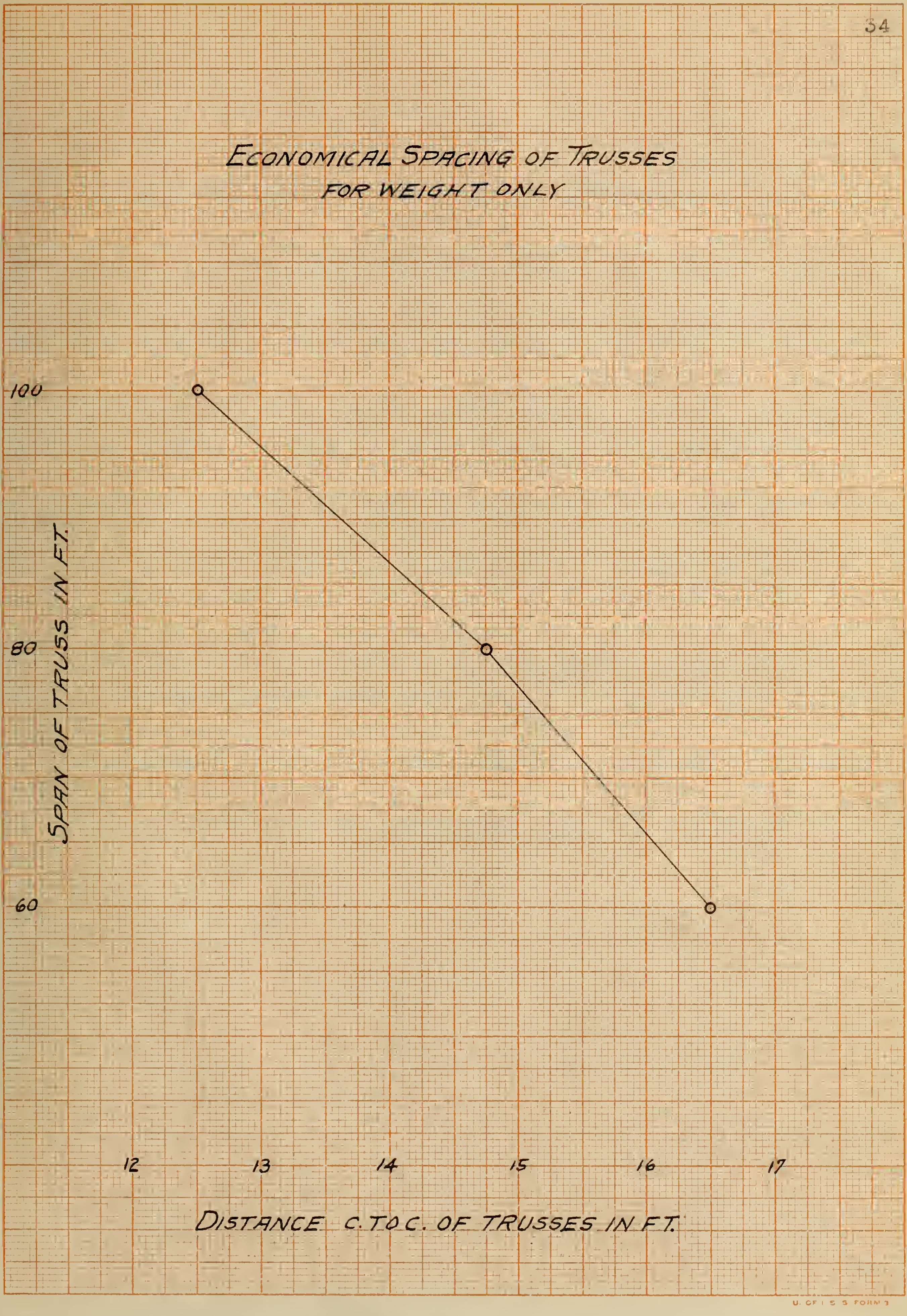
ECONOMICAL PITCH
FOR
VARIOUS SPANS
DISTANCE C. TO C. = 16 FT.
100
90
80
70
60
50
40
SPAN OF TRUSS IN FT.
1/5
1/4
30°
1/3
PITCH OF TRUSSES

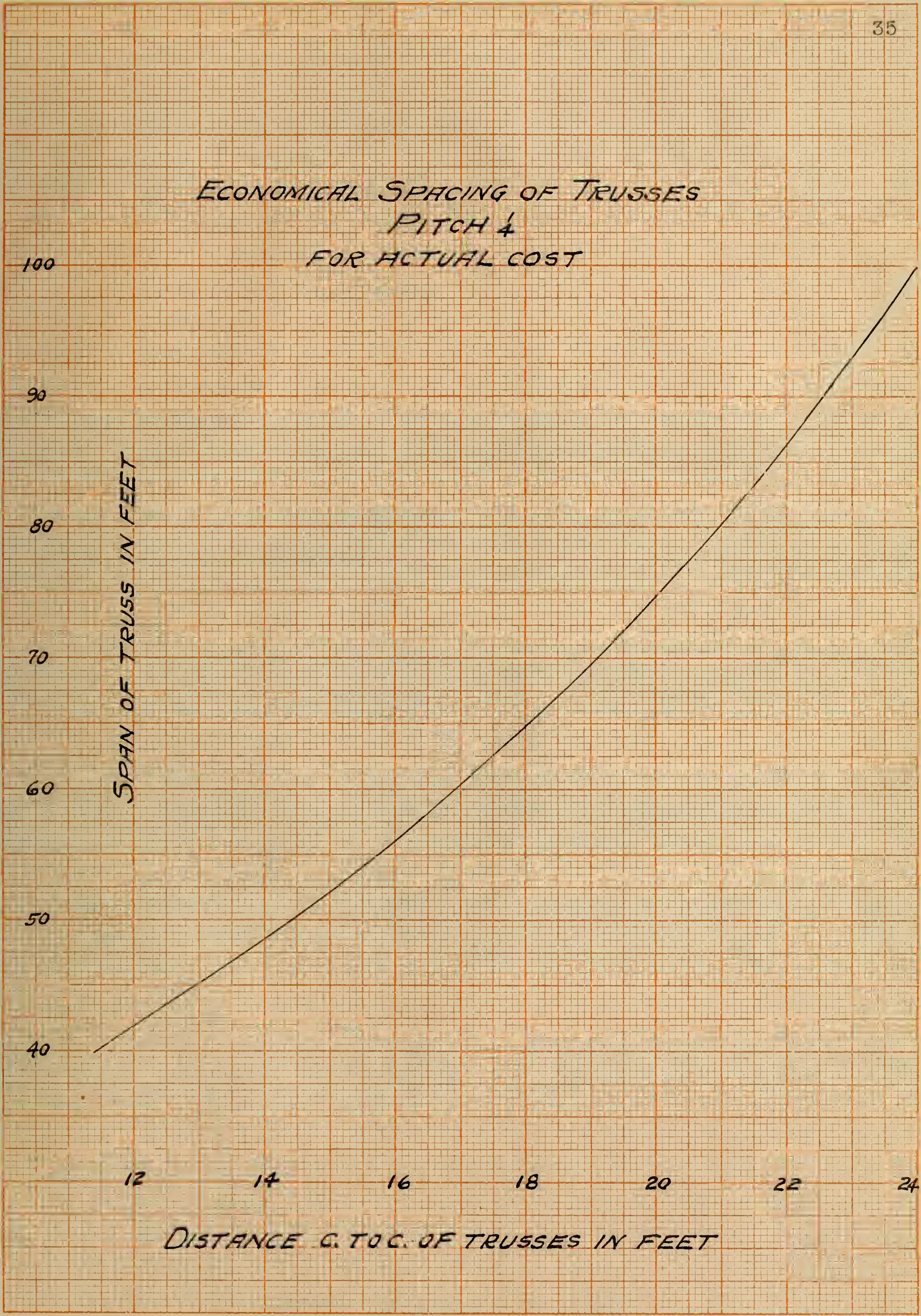

VARIATION OF WEIGHT OF TRUSS
WITH
VARIATION OF SPAN
PITCH 1/4
12'-0" C. TO C.
16'-0" C. TO C.
20'-0" C. TO C.
WEIGHT IN POUNDS PER HORIZONTAL SQ. FT.
5.0
4.0
3.0
2.0
40
60
80
100
SPAN OF TRUSS IN FEET

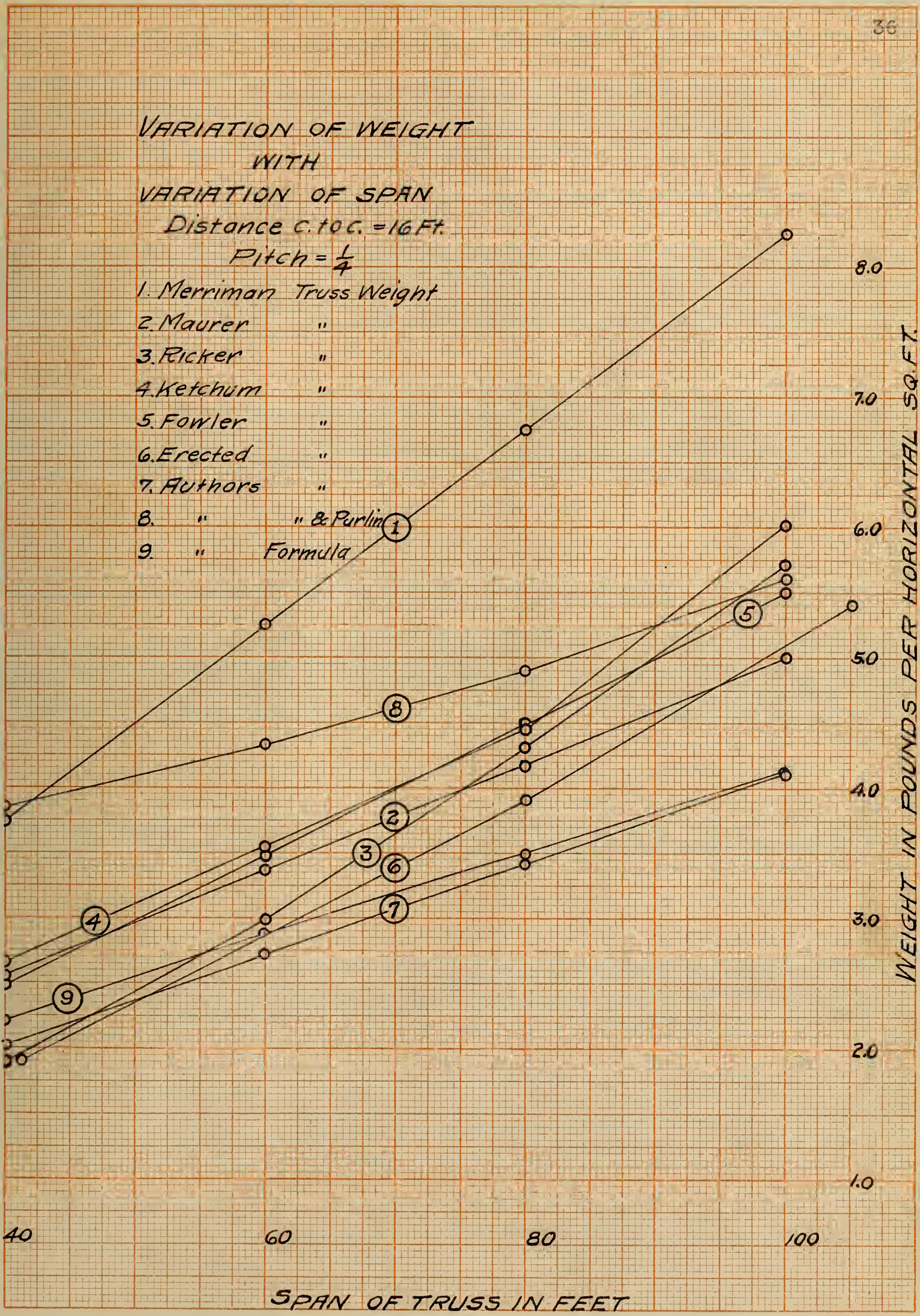


VARIATION OF WEIGHT OF PURLIN
WITH
VARIATION OF SPAN
PITCH 1/4
20'-0" C. TO C.
16'-0" C. TO C.
12'-0" C. TO C.
3.0
2.5
2.0
1.5
1.0
WEIGHT IN POUNDS PER HORIZONTAL SQ. FT.
40
60
80
100
SPAN OF TRUSS IN FEET


ECONOMICAL SPACING
OF TRUSSES
PITCH 1/4
SPAN 100 FT.
SPAN 80 FT.
SPAN 60 FT.
WEIGHT OF TRUSS AND PURLINS IN POUNDS PER HORIZONTAL SQ. FT.
6.2
6.0
5.8
5.6
5.4
5.2
5.0
4.8
4.6
4.5
12
16
20
DISTANCE C. TO C. OF TRUSSES IN FEET


ECONOMICAL SPACING OF TRUSSES
FOR WEIGHT ONLY
SPAN OF TRUSS IN FT.
100
80
60
12
13
14
15
16
17
DISTANCE C. TO C. OF TRUSSES IN FT.


ECONOMICAL SPACING OF TRUSSES
PITCH 1/4
FOR ACTUAL COST
100
90
80
70
60
50
40
SPAN OF TRUSS IN FEET
12
14
16
18
20
22
24
DISTANCE C. TO C. OF TRUSSES IN FEET


VARIATION OF WEIGHT
WITH
VARIATION OF SPAN
Distance C. to C. = 16 Ft.
Pitch = 1/4
1. Merriman Truss Weight
2. Maurer "
3. Ricker "
4. Ketchum "
5. Fowler "
6. Erected "
7. Authors "
8. " " & Purlin
9. " Formula
1
2
3
4
5
6
7
8
9
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
40
60
80
100
WEIGHT IN POUNDS PER HORIZONTAL SQ. FT.
SPAN OF TRUSS IN FEET